

VI. MOLECULAR BEAM RESEARCH

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A. THE HYPERFINE STRUCTURE ANOMALY OF THE POTASSIUM ISOTOPES

The nuclear magnetic moment and atomic hyperfine splitting of the rare K^{40} isotope have been measured by the atomic beam magnetic resonance technique. K^{40} atoms were detected from a source of normal potassium by employing a conventional surface ionization detector as the ion source for a mass spectrometer and by utilizing an electron multiplier to count the K^{40} ions. By measuring the frequencies of appropriate lines in the Zeeman pattern, the nuclear moment was determined to be $\mu_I = -1.2964 \pm 0.0004$ nuclear magnetons. The hyperfine splitting in the ground state was again determined, with higher precision than that of previous measurements, to be $\Delta\nu = 1285.790 \pm 0.007$ Mc/sec.

The ratio of the nuclear g factors of K^{39} and K^{40} was measured directly by observing, in the same homogeneous magnetic field H , the frequencies of two lines (a doublet) in the Zeeman spectrum of each isotope. The doublet separation of these lines is in each case proportional to $2g_I\mu_o H$, so that the ratio of the doublet splittings yielded directly $|g(K^{40})/g(K^{39})| = 1.24350 \pm 0.00024$. From these results, and from the previously measured $\Delta\nu(K^{39})$, the hyperfine structure anomaly of these K isotopes is

$$\frac{[2I(K^{40})+1]g(K^{40})\Delta\nu(K^{39})}{[2I(K^{39})+1]g(K^{39})\Delta\nu(K^{40})} - 1 = (0.466 \pm 0.019) \text{ percent.}$$

The theory of the hyperfine structure anomaly, as developed by A. Bohr and V. F. Weisskopf, has been applied to the interpretation of this result. The predictions of a number of specific models, previously suggested to account for the observed nuclear g factors, have been compared with this experiment and with previous results on the anomalies for the Rb and the abundant K isotopes. The "asymmetric core" model of A. Bohr gives the best over-all agreement, mainly on the basis of the $K^{41} - K^{39}$ anomaly. In general, all models which are, in their essential features, based on the independent particle model with spin-orbit coupling, give predictions in fair qualitative agreement with the experiments. However, the contribution of K^{40} to the hfs anomaly (fortuitously) seems to be insensitive to the differences between the models investigated.

A paper which deals fully with the method and theory of these experiments has been submitted to the Physical Review.

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B. DETECTION TECHNIQUES

The investigation of the detection of halogen beams (see Quarterly Progress Report, October 15, 1951) has been extended to iodine, which has the lowest surface ionization probability of the group. An absolute comparison of its detection efficiency with that of chlorine is being obtained by using the dissociation product of iodine monochloride as the source of atoms.

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